

**CALIFORNIA DEPARTMENT OF FISH AND GAME
IN-CHANNEL PROJECT REVIEW GUIDELINES
FOR PROTECTION OF
DELTA SMELT (*Hypomesus transpacificus*),
WINTER-RUN CHINOOK SALMON (*Oncorhynchus tshawytscha*)
AND SPRING-RUN CHINOOK SALMON (*Oncorhynchus tshawytscha*)
IN THE SACRAMENTO-SAN JOAQUIN ESTUARY**



April 2005

Cover photo by Lester Yamaguchi

FOREWORD

This document is an updated version of the “California Department of Fish and Game Project Review Guidelines for Delta Smelt (*Hypomesus transpacificus*) Protection in the Sacramento –San Joaquin Estuary,” which was prepared in March 1996. The new version covers two additional listed species: winter- and spring-run Chinook salmon (*Oncorhynchus tshawytscha*).

INTRODUCTION

As the rapid pace of development continues, the fate of sensitive species has become an increasing concern among biologists and environmental planners. On an individual project basis, effective mitigation strategies may reduce impacts to certain sensitive species to less-than-significant levels, but cumulative habitat loss continues on a regional basis. The California Department of Fish and Game (DFG) has examined primary elements essential to the management and recovery of species in the Sacramento-San Joaquin estuary in order to develop appropriate conservation measures. The basic strategy for recovery is to manage the estuary so that it provides quality habitat for native fish in general and listed species in particular.

The Legislature and the Fish and Game Commission (FGC) have developed policies, standards and regulatory mandates which, if implemented, are intended to help stabilize and reverse dramatic population declines of threatened and endangered species. Central Valley Bay-Delta Branch (CVBDB) staff has prepared this report in order to help the California Department of Fish and Game (DFG) evaluate the adequacy of mitigation measures designed to offset impacts to delta smelt (*Hypomesus transpacificus*), winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and spring-run Chinook salmon (*Oncorhynchus tshawytscha*) (henceforth referred to as “listed species”) from in-channel modification projects in the Sacramento-San Joaquin Estuary (Estuary).

This report is designed to provide the DFG regional offices and branches, CEQA Lead Agencies, and project proponents the context in which the Department will review proposed project specific mitigation measures. The DFG hopes that these guidelines will encourage resolution of potential conflicts as early as possible and that they will provide a mechanism for informal consultation.

This report also includes “model” mitigation measures which have been judged to be consistent with policies, standards, and legal mandates of the Legislature and Commission. Alternative mitigation measures, tailored to specific projects, may be developed if they are consistent with this report. Implementation of any mitigation measures is intended to further the conservation of delta smelt and winter- and spring-run Chinook salmon and should complement multi-species planning efforts currently underway. Project proponents must also ensure that any other requirements of CEQA and CESA, as well as the Federal Endangered Species Act (FESA) and any other applicable laws, permits, or policies, are met.

DFG participated in a Delta Native Fishery Recovery Plan (DNFRP) (USFWS 1995). The DNFRP established criteria for species recovery through preservation of existing habitat, expansion of former habitat, improved recruitment of young into the population, and other specific recovery efforts. The basic strategy has been to improve estuarine conditions so that they “provide better habitat for native fish in general, and delta smelt in particular” (USFWS 1995).

During project review, DFG should consider whether the proposed project will adversely affect suitable habitat conditions required by listed species during specific life stages (spawning, larval and juvenile transport, rearing and foraging, and adult migration) and thereby affect efforts to ensure the species=protection and eventual recovery. Suitable delta smelt habitat will be those habitats identified in the U.S. Fish and Wildlife Service (USFWS) Federal Register (USFWS 1994), DNFRP, and California Department of Fish and Game Report to the Fish and Game Commission (1993). Suitable winter- and spring-run Chinook salmon habitat will be those habitat types identified in the Federal Register by National Marine Fisheries Service (NMFS) (NMFS 1993 for winter-run; 2000 for spring-run).

LEGAL STATUS OF LISTED SPECIES

Federal

Delta smelt:

The delta smelt was listed as a federally threatened species on March 5, 1993. The term “threatened species” is defined in the FESA of 1973 as any species “which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range” 16 U.S.C. Section 1532(6).

Winter-run Chinook salmon:

The winter-run Chinook salmon was listed as a federally threatened species on November 5, 1990 and was reclassified as an endangered species on February 3, 1994. The term “endangered species” is defined in the FESA of 1973 as any species “which is in danger of extinction in all or part of its range.”

Spring-run Chinook salmon:

The spring-run Chinook salmon was listed as a federally threatened species on November 15, 1999.

State

Delta smelt:

The delta smelt was listed as a “threatened species” pursuant to the California Endangered Species Act (CESA) on December 9, 1993. Under the CESA, a threatened species is a “native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required@ (Fish and Game Code section 2067).

Winter-run Chinook salmon:

The winter-run Chinook salmon was listed as a state endangered species under CESA in August 1989. Under CESA, an “endangered species” is a “native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, or its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease.” (Fish and Game Code Section 2062)

Spring-run Chinook salmon:

The spring-run Chinook salmon was listed as a state threatened species under CESA on February 5, 1999.

**LEGISLATIVE AND COMMISSION POLICIES,
LEGAL MANDATES AND STANDARDS**

The Commission policy for threatened species is, in part, to: “Protect and preserve all native species...and their habitats...” This policy also directs DFG to work with all interested persons to protect and preserve sensitive resources and their habitats. Consistent with this policy and direction, DFG is enjoined to implement measures that assure protection for the delta smelt, winter-run Chinook and spring-run Chinook.

Under the Fish and Wildlife Coordination Act, federal agencies are required to consult with USFWS and DFG before beginning projects that control or modify surface water. This consultation is intended both to promote the conservation of wildlife resources by preventing loss of, or damage to, wildlife resources and to provide for the development and improvement of wildlife resources in connection with water projects. Federal agencies undertaking water projects are required to include, in their project reports, recommendations made by the USFWS, NMFS and DFG; and to include means and measures for wildlife purposes in their project plans.

The COE permit authority derives from the Section 404 of the Clean Water Act and applies to all waters of the United States. The Clean Water Act prohibits the discharge of dredged or fill material except in compliance with section 404. Under section 404, General Permits may be issued after careful consideration and are a useful tool in protecting the environment with a minimum of red tape and delay.

The California Legislature, when enacting the provisions of CESA made the following findings and declarations in Fish and Game Code Section 2051:

- a) Certain species of fish, wildlife, and plants have been rendered extinct as a consequence of man’s activities, untempered by adequate concern and conservation.

b) Other species of fish, wildlife, and plants are in danger of, or threatened with, extinction because their habitats are threatened with destruction, adverse modification, or severe curtailment because of over-exploitation, disease, predation, or other factors.

c) These species of fish, wildlife, and plants are of ecological, educational, historical, recreational, esthetic, economic, and scientific value to the people of this state, and the conservation, protection, and enhancement of these species and their habitat is of statewide concern.

The Legislature also proclaimed that it “is the policy of the State that State agencies should not approve projects as proposed which would jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat essential to the continued existence of those species....”

DEPARTMENT OF FISH AND GAME’S ROLE AND RESPONSIBILITIES IN PROJECT CONSULTATION AND ADMINISTRATION OF CEQA AND THE FISH AND GAME CODE

DFG, through its administration of the Fish and Game code and its public trust responsibilities, should continue its efforts to minimize further habitat destruction and should seek mitigation to offset unavoidable losses by: 1) including the mitigation measures described in this document in CEQA comment letters and/or as management conditions in DFG-issued Management Authorizations or 2) developing project specific mitigation measures (consistent with the Commission’s and the Legislature’s mandates) and including them in CEQA comment letters and/or as management conditions in Fish and Game Code Section 2081 Management Authorizations, and 3) recommending mitigation measures to be incorporated into FWCA reports, and COE 404 permits.

The Department should submit comments to CEQA Lead Agencies on all projects which adversely affect State-listed species. CEQA requires a mandatory finding of significance if a project is likely to reduce the number or restrict the range of a threatened or endangered species (Section 15065). Adverse impacts must be: 1) avoided, 2) minimized, and/or 3) mitigated to less than significant levels. If adverse impacts cannot be avoided or mitigated, the lead agency must make and support findings of overriding consideration. If the CEQA Lead Agency makes a Finding of Overriding Consideration or the project is Categorically Exempt, it does not eliminate the project sponsor’s obligation to comply with CESA and Fish and Game Code Section 2080 (Incidental Take Permit). The take of State-listed species may be a violation of Section 2080 of the Fish and Game Code. To avoid potential violations of Fish and Game Code Section 2080, the Department will recommend and encourage project sponsors to obtain a 2081 Incidental Take Permit or a Consistency Determination (2080.1) where possible.

The mitigation measures incorporated into CEQA comment letters and/or 2081 Incidental Take Permits for a project should be consistent with Sections 2053 and 2054 of the Fish and Game Code. Section 2053 states, in part, “it is the policy of the State that State agencies should not approve projects as proposed which would jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat essential to the continued existence of those species, if there are reasonable and prudent alternatives available consistent with conserving the species or its habitat which would prevent jeopardy”. Section 2054 states that “The Legislature further finds and declares that, in the event specific economic, social, or other conditions make infeasible such alternatives, individual projects may be approved if appropriate mitigation and enhancement measures are provided”.

HISTORICAL AND CURRENT POPULATION STATUS

Delta smelt:

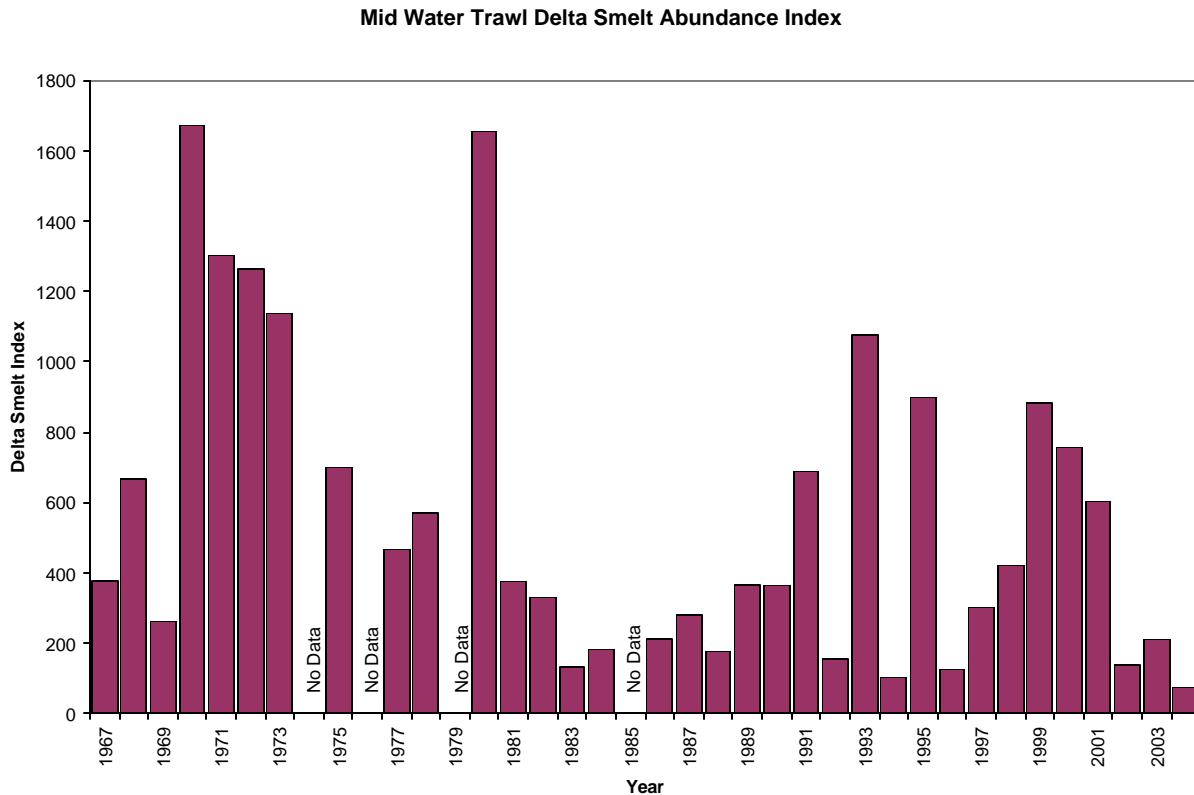
Delta smelt were once one of the most common pelagic fish in the upper Sacramento-San Joaquin estuary, as indicated by its abundance in trawl catches (Erkkila et al. 1950, Radtke 1966; Stevens and Miller 1983). Delta smelt abundance, as represented by an adult population index, has fluctuated from year to year, but between 1982 and 1992 the population was consistently low. The decline became precipitous in 1982 and 1983 due to extremely high outflows, and it continued through the drought years of 1987-1992 (Moyle et al. 1992). In 1993, the population increased considerably, apparently in response to a wet winter and spring.

During the period of 1982-1992, most of the population was confined to the Sacramento River channel between Collinsville and Rio Vista (D. Sweetnam, DFG unpublished). This was still an area of high abundance in 1993, but delta smelt were also abundant in Suisun Bay (USFWS 1995). The population dropped to an extremely low level in 1995, rose in 1996, dropped again in 1997 and then began a gradual climb until 1999. Smelt abundance declined slightly in 2000 and again in 2001, and then had a precipitous decline in 2002 after which the population has fluctuated slightly but at a much lower level.

Although average abundance has been higher since 1993 than the decade between 1980 and 1992, none of the peaks have reached levels seen prior to 1980 (Figure 1). Additional updated information on delta smelt abundance and distribution is available on the web at www.delta.dfg.ca.gov. The following surveys have websites that are updated regularly: 20 mm Survey, Spring Kodiak Trawl, Summer Townet Survey, and Real Time Monitoring.

The actual size of the delta smelt population is not known. Evaluations of delta smelt population trends are based on abundance indices calculated since 1959 for the Summer Townet Survey (STNS),

Figure 1



and since 1967 for the Fall Midwater Trawl (FMWT). These surveys indicated that the smelt population varies dramatically from year to year, but declined to low values in the early 1980s and remained at a severely low level with a few spikes. After 1997, the population index began a steady climb upward for three years, and then began a decline, which continued in 2002 with a precipitous drop. Stevens et al. (1990) estimated the population size to be about 280,000 in 1985, however this value is based on a tenuous relationship between numbers of delta smelt and numbers of young striped bass (*Morone saxatilis*) and is an imperfect estimate. In addition, the pelagic life style of delta smelt, short life span, spawning habits, and relatively low fecundity indicate that a fairly substantial population probably is necessary to keep the species from becoming extinct (USFWS 2004).

Winter-run Chinook salmon:

Winter-run Chinook currently spawn only in the Sacramento River, downstream of Keswick Dam. In the early 1990's, the spawning population had dropped to extremely low levels (191 adult fish in 1991), but in the last few years the population has rebounded to the highest level since the 1980's (6,948 and 7,598 estimated naturally spawning adults in 2002 and 2003 respectively) (California Department of Fish and Game 2004). These higher population numbers are still well below the proposed recovery goal of 10,000 females over 13 consecutive years (NMFS 1997).

Spring-run Chinook salmon:

Spring-run salmon in the San Joaquin River was extirpated in 1949, due to construction of the Friant Dam. The Sacramento River spring-run is considered to have been historically the most abundant stock in the Central Valley. Now there is only a remnant run in the Sacramento River and its tributaries. In 1967, the estimated spawning population was 27,335. In 1991, the population was estimated at 1,641 (Department of Fish and Game 1994, in draft).

REASONS FOR DECLINE

Delta smelt

The DNFRP has identified factors which have contributed to the decline of delta smelt. These multiple causes are synergistic, and include: 1) reduction in outflows; 2) entrainment losses to water diversions; 3) exceptionally high outflows; 4) changes in food organisms; 5) toxic substances; 6) disease, competition, and predation; and 7) loss of genetic integrity. (See Appendix A for detailed information on various causes of decline.)

Winter- and Spring-run Chinook salmon

Historic population declines can be attributed mainly to loss of upstream habitat behind impassable dams, impaired altered instream flow, entrainment of juveniles at Delta export facilities and other water diversions, up and downstream passage, elevated water temperatures, harvest, and loss of migrating fish (both juveniles and adults) in the estuary (USFWS 1995).

According to the DNFRP, continuing declines can be attributed to a variety of factors, including: 1) habitat loss; 2) harvest; 3) outmigrant (smolt) mortality; 4) hybridization with fall Chinook; and 5) disease.

Modification of habitat is the biggest single reason for these species' listing. Both the Delta and Suisun Marsh have been altered by reductions in outflows caused by increased diversion of inflowing freshwater. Water diversions in the Delta and upstream also result in losses of fish due to entrainment. Other factors (natural or manmade) that can affect the continued existence of winter and spring-run Chinook salmon include exceptionally high outflows, changes in food organisms, toxic substances, disease and predation, and loss of genetic integrity. The DNFRP determined that active management will be required for the foreseeable future to enhance and restore aquatic habitat in order to reverse declines of native fish and recover numbers and distribution to historical levels.

Dredging is one activity which requires active management to reduce its effects. Dredging destroys spawning habitat, mobilizes sediments containing toxic substances, blocks fish movement, and reduces the quality and quantity of shallow water habitat. Dredging occurs continually throughout the

Delta and its tributaries, as well as in Suisun Bay and Suisun Marsh. The magnitude of the adverse effects of dredging is dependent on time of year and location within the Delta or Suisun Bay.

DISTRIBUTION AND TIMING

To determine distribution and timing of delta smelt and salmonid movements in the Estuary, DFG conducts a series of surveys intended to provide crucial information on all life stages of these fish from newly hatched larvae to adult. These studies also provide a way to plan in-channel projects to avoid or reduce their effect on the species. In addition to surveys, the number of listed fish salvaged at the SWP and CVP fish facilities may indicate the presence of listed fish in the south Delta channels.

Delta Smelt Surveys

The following section describes the surveys that are used to assess various aspects of delta smelt population and life history.

20mm Survey:

The objective of this special set of surveys is to monitor post-larval and juvenile delta smelt distribution throughout their historical spring range in the Sacramento-San Joaquin Estuary. Twenty millimeters is considered the length when delta smelt become vulnerable to salvage at the State Water Project (SWP) and Central Valley Project (CVP).

These surveys are intended to provide real-time information (each survey takes 6 days) as to the distribution and relative abundance of delta smelt throughout the upper Estuary. A decision can then be made as to whether the flows were sufficient to maintain delta smelt rearing habitat away from the south and central delta. In addition to fish catch, zooplankton samples (delta smelt prey) are taken concurrently with a Clarke-Bumpus net attached to the 20-mm net frame.

Summer Tow Net Survey (STNS):

The STNS is conducted in June and July, and sometimes August. The STNS is used to develop an abundance index that is thought to be one of the more representative indices, because the data has been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) and for the longest period of time (since 1959). The STNS determines abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species.

The specific season when suitable habitat conditions are important for successful larval transport varies from year to year depending on when peak spawning occurs. Therefore, habitat conditions suitable for transport of larvae and juveniles may be required as early as February 1 or as late as August 31. Depending on outflow conditions and where the salinity gradient (2 ppt) is located in the Estuary,

the specific geographic area where larvae and juveniles may occur extends eastward from the Napa River and the Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break. Protection of rearing habitat conditions may be required from the beginning of February to the end of August.

Fall Midwater Trawl Survey (FMWT):

The FMWT is conducted during September through December, sometimes into April, and surveys the entire delta smelt general distribution range. The FMWT provides a good measure for late juvenile and adult delta smelt in a large geographic area (San Pablo Bay, upstream to Rio Vista on the Sacramento River and to Stockton on the San Joaquin River.) The FMWT provides a better measure of adult delta smelt abundance because it samples pre-spawning adult fish. The resulting index, based on pre-spawning adults rather than on juveniles (which are vulnerable to high mortality), provides a better estimate of delta smelt stock and recruitment.

Spring Midwater Trawl Survey (SMTS):

The SMTS will be replaced as of 2002 with the Spring Kodiak Trawl.

Spring Kodiak Trawl Survey:

The Spring Kodiak Trawl Survey (started in 2002) runs every other week beginning in February and ending in May. Each Delta-wide survey takes 4-5 days and samples 39 stations from the Napa River to Stockton on the San Joaquin River, and to Walnut Grove on the Sacramento River. The Delta-wide survey locates the areas of highest delta smelt concentration, and is followed by a supplemental survey two weeks later. The supplemental survey is designed to sample the areas of high concentration intensively, in order to estimate the proportion of ripe, unripe, and spent delta smelt. Delta-wide surveys are numbered consecutively beginning with number 1, and 'Supplemental' surveys are numbered consecutively beginning with number 11.

Delta Smelt Salvage:

Salvage is done at screened water diversions of the Central Valley Project (CVP) and State Water Project (SWP). Although salvaged delta smelt are trucked back to the western Delta, there are significant losses during transport. The CVP and SWP facilities are located at the southern edge of the Delta, miles from the current spawning areas. Despite their location, substantial entrainment losses of larvae occur at these facilities. These losses may occur due to the magnitude of the water project diversions, alteration of Delta flow patterns, and the tendency for young delta smelt to be transported to the intakes by estuarine currents.

All delta smelt life stages are vulnerable to entrainment, which is generally greatest during spring and summer. Historical salvage data gathered from the fish facilities at the SWP and CVP reported that peak total monthly salvage occurred during the months of May and June. This pattern reflects the late

winter-spring spawning season and consequent growth and mortality of young-of-the-year fish. In addition, during April and May the true abundance of young smelt at the SWP and CVP diversions is likely to be greater than indicated by the salvage numbers. This is due to many of the delta smelt being so small at that time of year that they pass through the screens. It is assumed that the diversion screens are not efficient at diverting larvae smaller than 20 mm in length. Therefore, delta smelt are not successfully salvaged for the first month or two of life.

Real Time Monitoring Program (RTM):

The RTM (started in 1995) was to provide data of listed fish distribution and abundance and to report those data, in a rapid fashion, to water managers for use in water management decisions. The goal of RTM was to protect listed species from entrainment by the SWP and the CVP. Surveys originally participating in the RTM were: U.S. Fish and Wildlife Service (USFWS) Beach Seine and Trawling surveys (target species are juvenile Chinook salmon, delta smelt, and juvenile Sacramento splittail); DFG 20-mm survey (target species is juvenile delta smelt); DFG Region 4 Kodiak trawling at Mossdale on the San Joaquin River (target species are juvenile Chinook salmon, and juvenile Sacramento splittail); DFG RTM light trapping survey (target species is larval delta smelt); salvage from the SWP/CVP (no set target species). In 2000, most directed studies were wrapped up and RTM became a means of communicating data via the web.

Data are reported via the internet or by the Data Analysis Team (DAT) conference calls. Data from salvage, RTM Light Trapping, and the USFWS are reported through the RTM web page (<http://www.delta.dfg.ca.gov/data/rtn2004/>) while data from the 20-mm Survey is reported through its own web page (<http://www.delta.dfg.ca.gov/20mm/>).

Salmon Surveys

Beach seining:

Beach seining has been conducted weekly at a number of locations since 1976 on the Sacramento River and in the North and South Delta. This survey is designed to estimate the abundance and distribution of salmonid fry using the Delta as a nursery and rearing area.

Midwater and Kodiak Trawl:

Trawling has been conducted at Pittsburg in Suisun Bay since 1976. It was started as an April through June survey to monitor peak fall-run outmigration, but is now conducted year-round to monitor all races of Chinook and estimate the relative abundance, timing, and size of fry and smolts entering the delta.

The midwater trawl survey at Sacramento has been conducted since 1988 (in 1990 the site was near Hood). From 1976 to 1981, the trawl was conducted at Clarksburg on the Sacramento River. Again, early years emphasized the April to June months when fall-run outmigration occurs, but since

1992, sampling has been expanded to encompass the outmigration periods of spring, late-fall, and winter-run Chinook. In December, 1994, this gear was replaced during the winter months by the Kodiak trawl, which has a better efficiency for catching larger juvenile Chinook salmon such as winter and late-fall run. A midwater trawl station at Chipps Island is used to estimate the number of unmarked fish emigrating from the Delta and to recover marked smolts released in mark and recapture survival experiments.

PRIMARY ELEMENTS FOR CONSERVATION

The following are the primary elements necessary to conserve delta smelt, winter-run Chinook, and spring-run Chinook. These elements are organized by habitat conditions required for each life stage. In addition, specific areas containing these primary elements were identified through surveys. It is important to note that the identification of specific areas important to these species does not preclude primary elements occurring in other areas.

Delta smelt

Spawning Habitat: Delta smelt adults seek shallow, freshwater (i.e. less than 2 ppt salinity) river, and backwater slough edgewater for spawning. To ensure egg hatching and larval viability, spawning areas also must have suitable water quality and substrates for egg attachment (submerged tree roots, branches, rock, and emergent vegetation). The spawning season varies from year to year, and may start as early as December and extend until July. As mentioned earlier, the USFWS Federal Register has identified the following specific areas as important delta smelt spawning habitat: Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. The newly discovered spawning activity in the Napa River should be considered as well, although the fate of juveniles in the Napa River is not known.

Larval and Juvenile Transport: To ensure that delta smelt larvae are transported from the area where they are hatched to shallow productive rearing or nursery habitat, the Sacramento and San Joaquin rivers and their tributary channels must be protected from physical disturbance (e.g. sand and gravel mining, diking, dredging, and levee or bank protection and maintenance) and flow disruption (e.g. water diversions that result in entrainment, and in-channel barriers or tidal gates). The specific season when suitable habitat conditions are important for successful larval transport varies from year to year depending on when peak spawning occurs. Habitat conditions suitable for transport of larvae and juveniles may, therefore, be required as early as February 1 and as late as August 31.

Rearing Habitat: Appropriate location of the 2 ppt salinity isohaline and suitable water quality (low concentrations of pollutants), within the Estuary, are necessary to provide delta smelt

larvae and juveniles a shallow, protective, food-rich environment in which to mature. Outflow conditions will determine where the salinity gradient is located in the Estuary. The area extending eastward from the Napa River and Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area in which it is critical to maintain suitable rearing habitat (USFWS 1994). Protection of rearing habitat conditions may be required from the beginning of February to the end of August.

Adult Migration: Delta smelt live principally in the upper portion of the water column. Adult delta smelt must be provided unrestrained access to suitable spawning habitat in a period that may extend from December to July. Therefore, adequate flow and suitable water quality must be maintained to attract migrating adults into the Sacramento and San Joaquin River channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas should be protected from physical disturbance and flow disruption during migratory periods.

Winter- and Spring-run Chinook Salmon

Adult and Juvenile Migration: Adult salmon migrate through the Delta on their way to tributary streams where they will spawn. Out-migration of smolts occurs at varying times depending on race and conditions, and the smolts are thought to stay near the edges of the channel in shallower water during the day, and move out into deeper water to migrate further downstream at night.

The most significant fisheries impacts can be attributed to bank protection projects, which typically require removal of nearshore riparian vegetation, grading of the bank slope, and placement of rock revetment over the graded slope. Shaded riverine aquatic habitat is of greatest concern because of the unique fishery values associated with this habitat type and substantial losses that have already occurred. Replacement of naturally eroding banks with rock revetment has been shown to locally reduce densities of juvenile Chinook salmon; with Chinook salmon densities in undisturbed areas typically 4-12 times higher than in riprapped sites (Michny and Hampton 1984, Michny and Deibel 1986).

CRITICAL HABITAT AND ESSENTIAL FISH HABITAT

Critical Habitat for Delta Smelt

The USFWS designated critical habitat for the threatened delta smelt pursuant to the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 et seq.) for an area encompassing the specific habitat conditions required for each life stage. The adopted critical habitat as

defined by the USFWS and described in the 1994 Federal Register is as follows:

- The specific areas within the geographical area occupied by the species on which are found those physical and biological features that are:
 - ◆ essential to the conservation of the species, and
 - ◆ which may require special management considerations or protection.
- The specific areas outside the geographical areas occupied by the species that are essential for the conservation of the species.

The USFWS final rule designates critical habitat for the delta smelt in the following geographic areas: "Areas of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous water contained within the Delta, as defined in section 12220 of the California Water Code. Critical habitat designation for the delta smelt will provide additional protection under Section 7 of the Act with regard to activities that require Federal agency action. The designated critical habitat is contained within Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties, California." See Appendix B for map of delta smelt critical habitat.

Essential Fish Habitat for Winter- and Spring-run Chinook Salmon.

The Magnuson-Stevens Fishery Conservation and Management Act (since renamed the Magnuson-Stevens Act) is the federal law that governs U.S. marine fisheries management. In 1996, Congress added habitat conservation provisions to the Magnuson-Stevens Act. Included in these conservation provisions, was a requirement that Essential Fish Habitat (EFH) be identified for managed species. NMFS, Councils, fishing participants, federal and state agencies, and others are required to cooperate in achieving EFH protection, conservation, and enhancement.

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). See Appendix C for maps of Essential Fish Habitat for winter- and spring-run Chinook salmon.

MANAGEMENT STRATEGIES

Management and mitigation strategies for the Estuary's population of listed species should ensure that:

- Suitable spawning habitat continues to be available (this should be accomplished by protecting

existing spawning habitat from destruction or disturbance and by increasing the extent of suitable spawning habitat).

- Suitable rearing and foraging habitat is available in the Estuary. Existing suitable spawning and foraging habitat should be maintained. Adequate and suitable habitat should be created in areas of existing and potential sites and along migratory routes and in rearing areas.
- Normal behavioral patterns of listed species which include, but are not limited to, feeding, spawning, migration, and sheltering are not disturbed through proposed in-channel activities.

A key to ultimate success in meeting the Legislature's goal of maintaining habitat sufficient to preserve these species is to implement these management strategies in cooperation with project sponsors and local, state, and federal agencies. To further this goal, a procedural regulatory review process has been developed, and is included in this document. The review process is intended to help coordinate and implement the management strategies, and ultimately streamline the regulatory process to provide the best possible protection to the species.

MANAGEMENT CONDITIONS

The following management conditions (numbered 1-8) are considered by DFG staff as preapproved for incorporation into any Incidental Take Permits issued by DFG for the delta smelt and winter- and spring-run Chinook, or as recommendations under the Fish and Wildlife Coordination Act and (COE) 404 permit. The incorporation of these management conditions into project design should reduce impacts to listed species to less than significant levels. Since these measures are staff recommendations, a project sponsor or CEQA Lead agency may choose to negotiate other project-specific mitigation measures. In such cases, the negotiated Management Conditions must be consistent with Commission and Legislative policy and be submitted to the Regions for review and approval prior to reaching agreement with the project sponsor or CEQA Lead Agency.

Note: all in-channel activities may require a Streambed Alteration Agreement (Fish and Game Code 1600). Also, complying with these work windows and having DFG approval does not release project proponent from obtaining Federal approval and complying with Federal work windows.

1. No new intensive disturbances (e.g. heavy equipment operation associated with construction, use of cranes or draglines, rock crushing activities) or other project-related activities should take place which may cause an increase in suspended sediments or an increase in resonance (sound) in the water. Increased sediment may reduce the feeding success of all life stages of listed fish, and increased resonance may induce stress in the species or interfere with other fish behavior such as spawning activities and migration. This management condition assumes that the type of work and

construction equipment (e.g. heavy equipment operation associated with construction, use of cranes or draglines, rock crushing activities) used will not change from what has typically or previously been used. This condition cautions against activities which may increase suspended sediments or increase resonance, and recommends that in-channel project activity be minimized. Projects will need to be reviewed on a case-by-case basis to see if any change in project activities falls into this condition. This review may also allow some activities, which would not otherwise be allowed, to occur under certain circumstances.

2. Information on listed species' life history, their temporal and spatial distribution, and salvage data was used to specify time windows and to delineate geographic zones that define when and where in-channel modifications may occur (Figure 2). The periods when in-channel modification is allowable generally coincide with times when listed species are potentially least vulnerable to the effects of these sorts of activities. By conducting activities during these time periods, direct loss of listed species should be minimized. One of the purposes of the map and the associated time windows is to alert the project proponent and lead agency about whether a project will need further DFG review regarding take of listed species. If any project is scheduled to be conducted during the period when in-channel modification activity is allowed, and if shaded riverine aquatic habitat and shallow shoal habitat are avoided, further project review may not be necessary. Additional information to clarify how the map should be interpreted is included in the regulatory review process section below. Appendix D provides a text description of the protection zones for listed species.

Zone A:

Delta smelt - This zone provides 1) protection for prespawning adults migrating to upstream areas and 2) protection of favorable rearing habitat in all areas. In the north and central Delta, it also provides 3) protection of eggs and transportation of larvae; and 4) spawning delta smelt in river channels and tidally influenced backwater sloughs.

Winter- and spring-run Chinook salmon – This zone provides protection for adults migrating upstream and outmigrating smolts, as well as rearing habitat for juveniles.

Avoid in-channel activities in this zone from December 1 through July 31.

Zone B:

Delta smelt- This zone provides 1) protection of eggs and the successful transport of larvae; and 2) favorable rearing habitat for juvenile delta smelt within the central and south tributaries, channels, and conveyance channels to the fish salvage facilities.

Winter- and spring-run Chinook salmon – This zone provides protection for adults migrating upstream, outmigrating smolts and possibly rearing habitat for juveniles.

Avoid in-channel activities in this zone from March 1 through July 31.

*Description of Protection Zones
for Delta Smelt and Winter and Spring-run
Chinook Salmon*

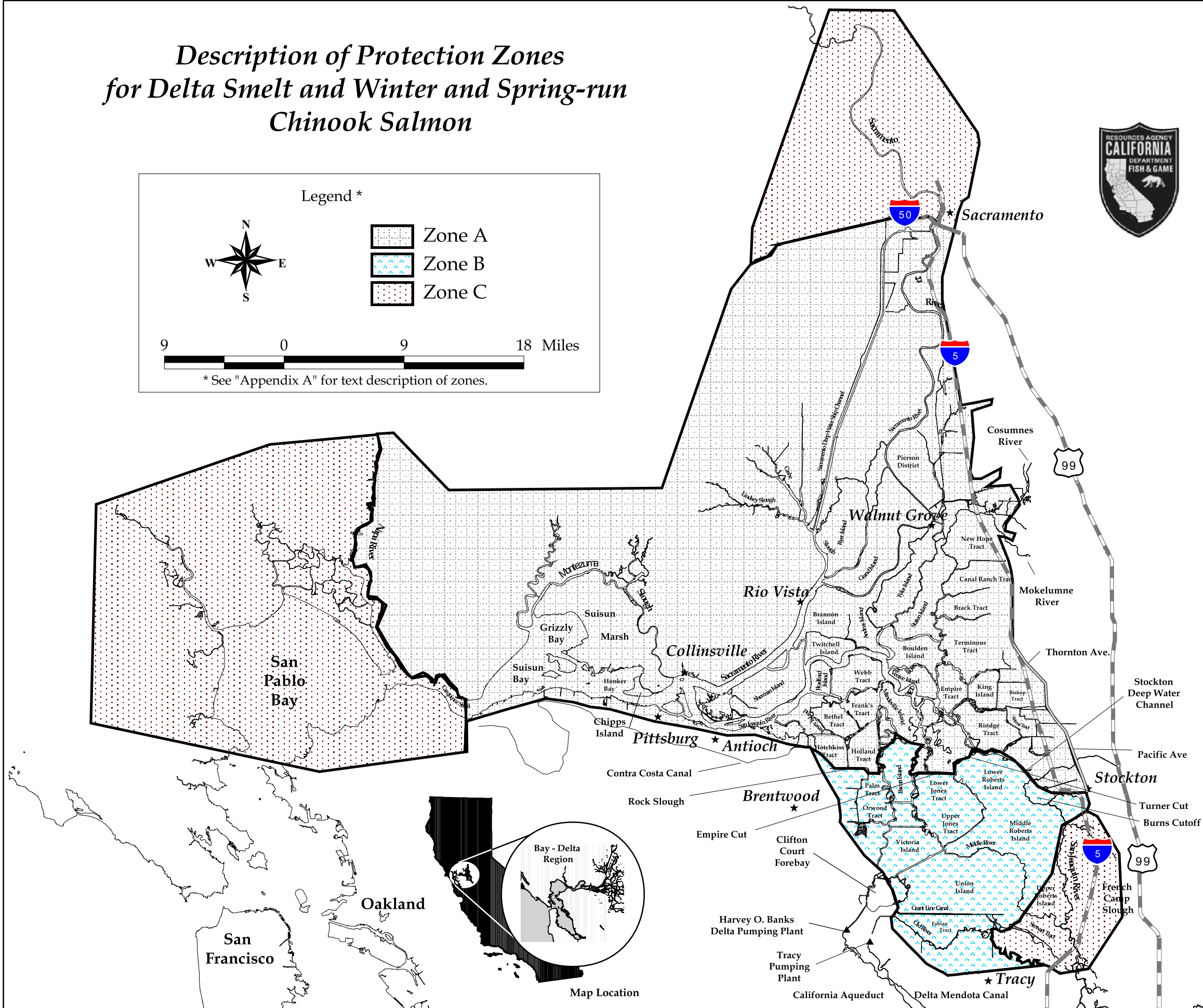
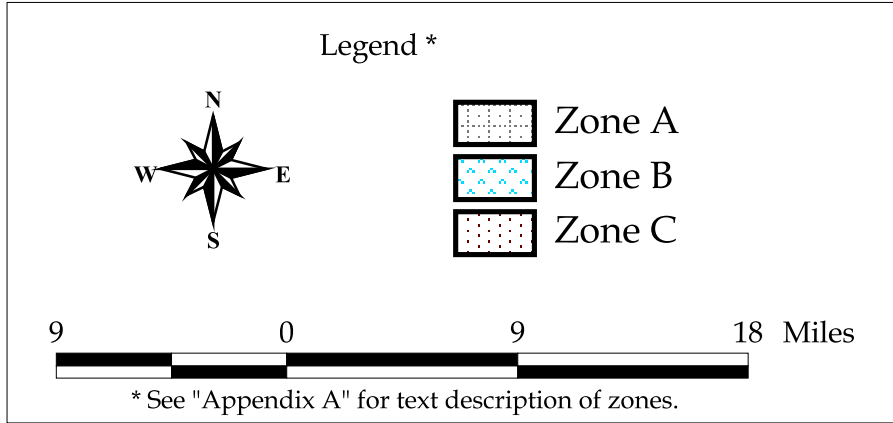


Figure 2. Description of Protection Zones for Delta Smelt and Winter and Spring - run Chinook Salmon.

DFG Project Review Guidelines for Protection of Delta Smelt, Winter-run Chinook Salmon and Spring-run Chinook Salmon in the Sacramento - San Joaquin Estuary.

Zone C:

This zone does not indicate time periods when projects should avoid in-channel work. However, in-channel activities which may result in the destruction or adverse modification of habitat essential to the species should be avoided in habitat areas critical to listed species (see Management Condition # 3).

Delta smelt are hydrologically influenced and their abundance and distribution within these zones in the Delta may fluctuate with different water-year types. However, various life stages of delta smelt occur in the Delta on a year-round basis. The allowable periods for in-channel modification work within each zone are based on times when delta smelt may be unaffected by, or least vulnerable to, in-channel activities. It is important for the protection of this listed species to acknowledge that they may be present in any part of their described range. Therefore, to provide the best possible protection for delta smelt, the different Zones (A, B, and C) were delineated with consensus among technical experts on delta smelt biology. These zones were also considered to provide protection for winter- and spring-run Chinook salmon during migration and rearing. These project review guidelines do for possible informal consultation and a review of specific mitigation measures, and compensation. Work that will take place near the boundary between zones needs to be evaluated on a case-by-case basis.

3. Protect habitat areas critical to listed species during in-channel activities which may result in the destruction or adverse modification of spawning and rearing habitat. The following describes habitat areas which should be avoided and delineates project impact area.

- Avoid all channel islands, shoals, and shoreline areas with emergent vegetation. All dredging adjacent to these areas where the bottom materials are composed of sand should be at a distance that will not result in an underwater slope greater than 10 horizontal to one vertical. To avoid disturbance to the shallow shoal areas utilized by listed species for rearing, no dredging shall be conducted within 200 feet of the shoreline and 250 feet of any water 4 feet or shallower in depth during mean low low water (MLLW) (Figure 3a) from the western boundary of Zone A, upstream to the confluence of the Sacramento and San Joaquin rivers.
- To protect valuable fish habitat, no dredging or water-side activity should occur in water less than 3 meters in depth in any zones, as measured at Mean High Water (MHW) for that site (Figure 3b). However, the following two conditions may warrant project review: 1) where the primary purpose of dredging is to obtain emergency fill material, there are no suitable dredge areas deeper than 3 meters within 200 feet of the dredge material deposition site, and no feasible alternative source of materials is available; and 2) dredging is required to increase channel depth or capacity for the primary purpose of flood control and/or navigation. In all instances where dredging occurs in water shallower than 3 meters at mean

Habitat Protection During In-Channel Modifications

Shallow Shoal Habitat: Zone A-2

Aviod dredging within 200 feet of shore

Aviod dredging within 250 feet of shallow water areas that are less than 4 feet in depth at MLLW

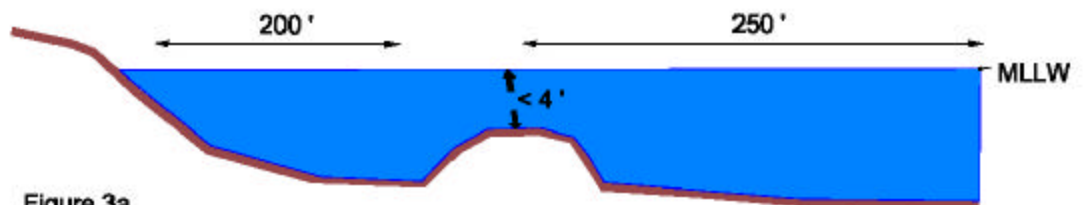


Figure 3a

Shallow Water Habitat: All Zones

Aviod dredging in water less than 3 meters in depth

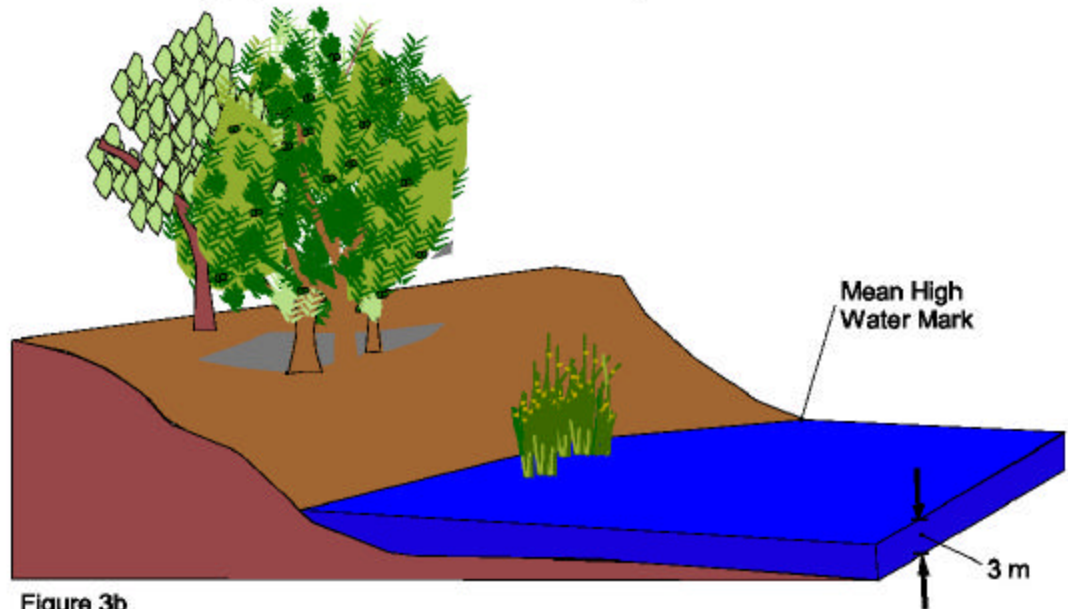


Figure 3b

high tide, the dredging should be confined and only done to a depth which would NOT cause sloughing and degradation of the adjacent shallow water habitat (USFWS 1994 b).

- To protect shallow water habitat and vegetated aquatic habitat, construction of waterside rock prisms (berms) and backfilling, which simplify habitat structure, reduce productivity of fish habitat, curtail spawning and rearing habitat, and eliminate escape cover from predators, should be avoided in the following critical spawning and rearing areas: Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog and Sycamore sloughs and the Sacramento River in the Delta, tributaries of northern Suisun Bay, and the specific geographic area where larvae and juvenile delta smelt may occur extending eastward from Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break.

In any case where impacts to these habitats cannot be avoided, the project proponent should follow the measures outlined in the mitigation measures section of this report. “Best management practices (BMPs)” are state-of-the-art techniques for managing various aspects of a project. The project proponent can determine the BMPs for their project. Projects will need to be reviewed on a case-by-case basis to see if any project activity needs to be covered by BMPs, or if any additional BMPs must be added. This review may also allow for some activities, which would otherwise be disallowed, to occur under certain circumstances.

4. Projects should use best management practices to minimize mobilization of sediments that might contain toxins. Many of the sediments throughout the Delta and its tributaries, as well as in Suisun Bay, contain toxic substances. These substances include mercury, used to separate gold during hydraulic operations; tributyltin (TBT), used to stop encrusting organisms on boat hulls; and selenium, a byproduct of oil-cracking operations and also a naturally occurring mineral found in soils in the San Joaquin River basin.

5. Use best management practices and silt curtains to localize sediment movement and reduce turbidity. These techniques should be used to minimize the effects of sediments during critical life-stages of listed species. This protective measure should be applied during all in-channel modification projects.

6. Prior to the onset of dredging operations, dredge materials from the proposed dredging site(s) will be tested for the presence of materials deleterious to aquatic organisms. This will occur for all projects dredging more than 100 cubic yards of material, and for all projects proposing aquatic disposal of dredged material. Samples will be collected and tested according to the procedures outlined in the U.S. Environmental Protection Agency and COE “Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual” (Inland Testing Manual) (USEPA

1998).

7. Any new water diversion shall be screened in a manner that complies with current DFG, USFWS, and NOAA Fisheries screening policies.
8. DFG is not allowing the use of creosote pilings. Therefore, no piling projects shall use creosote or creosote pilings.

DEPARTMENT REGULATORY REVIEW PROCESS

An internal DFG review process should be initiated if any project work is proposed outside the allowable period for project activity. This internal review process is also triggered if the proposed project threatens to affect shaded riverine aquatic habitat or shallow shoal habitat. Upon review, it will be determined whether additional protection measures are necessary, and suggested measures will be provided for incorporation into the project. For any project that is scheduled to be conducted during the allowable periods for project activity, and that doesn't affect any shaded riverine aquatic and/or shallow shoal habitat, coordination on listed species (under CESA) will not be necessary. However, protection of shaded riverine aquatic habitat and shallow water habitat should occur at all times (Management Condition #3). This does not obviate the need for federal compliance, and federal agency contact may be necessary.

In the 1990's, DFG was asked by the COE to combine the timing and location restrictions for both delta smelt and winter-run Chinook salmon in the Sacramento-San Joaquin Delta for project work under Senate Bill 34 (SB-34) and General Permit-014 (GP-14, which expired January 1, 2001 and has not been renewed). This effort resulted in a map depicting zones in the Sacramento-San Joaquin Delta and specified time periods of allowable construction activities which would avoid impacts to winter-run Chinook salmon and delta smelt (Figure 2). Although spring-run Chinook are covered by these time periods, they were not added to GP-014. Additional language was developed to clarify how the map should be interpreted.

MITIGATION AND CONSERVATION BANK LANDS

DFG should make it a standard practice to advise project proponents to initiate communication with the DFG as early as possible for projects that may impact listed species or the habitat upon which they depend.

Incidental Take may be authorized by the DFG through a permit, MOU, NCCP, HCP, habitat

management plan or other agreement. This authorization includes an analysis of potential project impacts to threatened and endangered (T&E) species. It also identifies general and site-specific mitigation requirements for species protection that project applicants must satisfy, during project construction and/or long-term operations, in order to avoid, minimize or fully mitigate impacts to T &E species or their habitats.

Mitigation for unavoidable impacts to spawning and rearing habitat can be provided through single-project on- or off-site mitigation lands (protected in perpetuity) or through purchase of “in-kind” credits from mitigation or conservation banks authorized by the DFG. DFG-approved mitigation/conservation banks and habitat credit types are administered by the Regions and by the Habitat Conservation Planning Branch (HCPB) Conservation Planning Program.

Mitigation/conservation banks are lands acquired by the private sector or public agencies to preserve, create, restore, and enhance habitat for special status species and for which credits may be sold to a project proponent or project sponsor in order to compensate for the loss of habitat for special status species. In the case of spawning and rearing habitat the Permittee/project sponsor shall provide mitigation (via a conservation/mitigation bank or other agreed mechanism) based on the following ratios.

The final ratios of any mitigation lands will be negotiated with DFG, but the following are some examples of the sort of ratios that may be used.

- Projects that involve in-channel activities and impact shallow water habitat (vegetated and nonvegetated, in areas of 3 meters and shallower measured at MHW), resulting in the temporary loss (less than one year) of that habitat, shall provide one acre of mitigation land for each acre impacted. Mitigation land shall be protected in perpetuity by fee title transfer or conservation easements and perpetual management of the mitigation lands shall be provided for through endowment fund, initial enhancement, etc.
- Projects that involve in-channel activities and impact shallow water, resulting in the permanent loss (greater than 2 years) of habitat, shall provide three acres of mitigation lands for each acre impacted. This land shall be protected in perpetuity by fee title transfer or conservation easements and perpetual management of the mitigation lands shall be provided for through endowment fund, initial enhancement, etc.
- Permittees/project sponsors shall provide a letter of credit or cash security that covers 1 year of operations.

For additional and more specific information on mitigation/conservation banking and mitigation requirements, contact the HCPB or see the HCPB web site on mitigation/conservation banking at <http://www.dfg.ca.gov/hcpb/conplan/mitbank/mitbank.shtml>.

All mitigation lands should be located in areas which are consistent with a multi-species habitat

conservation focus or priority. Therefore, mitigation lands proposed by Permittees/project sponsors should be located at sites which provide for the long-term conservation of habitat and species. Mitigation land proposals will be reviewed and approved by the DFG prior to acceptance. Mitigation/conservation banks approved by the DFG have been evaluated for their contribution to conservation.

These mitigation/conservation banks, if properly established and managed, serve several useful functions. First and foremost, mitigation/conservation banks provide for the protection of habitats and/or habitat linkages. Second, they provide a viable alternative to the less desirable practice of requiring piecemeal mitigation for individual project impacts. Individual on-site or off-site mitigation projects which have little connection with their surrounding ecosystem are much more prone to failure than a mitigation project which is incorporated into a larger, ecosystem-based mitigation/conservation bank or regional conservation plan. Conservation banks also provide significant incentives for private landowner participation and represent one of the best examples of private/public partnerships in an era of shrinking budget resources.

Although this report includes recommended Management Measures, the Department should encourage project proponents to propose alternative mitigation strategies that provide equal or greater protection to the species and which also expedite project environmental review or issuance of a CESA Incidental Take Permit.

Project applicants and CEQA Lead Agencies may also need to conduct site specific surveys to determine the status of listed species at the project site as part of the CEQA and 2081 Incidental Take Permit process. This should facilitate project review and reduce the potential for costly project delays.

DFG and the project sponsor may choose to conduct cooperative, multi-year field studies to assess the habitat value of a proposed project area. Study plans should include clearly designed methodology for evaluating listed species' habitat and for assessing potential project impacts on listed species. The study plans should be submitted to the Department for review and coordinated with the Resource Assessment Program at HCPB. Mitigation measures developed as a result of the study must be reviewed for consistency with the policies of the Legislature, Department, and Fish and Game Commission.

REVIEW

The goal of this report is to provide guidance to DFG staff and to provide basic information on the biological requirements for listed species. Protection measures are suggested to ensure that any action authorized, funded, or carried out by State, federal or private entities is not likely to jeopardize the continued existence of listed species and may benefit other native species. Staff should review this report at least annually to determine if the proposed mitigation strategies should be retained, modified, or if additional mitigation strategies should be included as a result of new scientific information.

REFERENCES CITED

- California Department of Fish and Game. 1993. Report to the Fish and Game Commission: A Status Review of the Delta Smelt (*Hypomesus Transpacificus*) in California. California Department of Fish and Game, 98 pp. + appendices.
- _____. 2004. Sacramento River Winter-run Chinook Salmon Biennial Report 2002-2003. Prepared for the Fish and Game Commission. CDFG, Habitat Conservation Division, Native Anadromous Fish and Watershed Branch. June 2004.
- Erkkila, L.F., J.W. Moffet, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin Delta fishery resources: Effects of Tracy Pumping Plant and the Delta Cross channel. U.S. Fish and Wildlife Service Special Scientific Report 56:1-109.
- Michny, F., and R. Deibel. 1986. Sacramento River Chico Landing to Red Bluff Project 1985 Juvenile Salmon Study. US Fish and Wildlife Service Sacramento, California. US Army Corps of Engineers.
- Michny, F., and M. Hampton. 1984. Sacramento River Chico Landing to Red Bluff project: 1984 juvenile salmonid study. Draft report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento, CA.
- Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society. 121: 67-77.
- National Marine Fisheries Service. 1997. Proposed recovery plan for the Sacramento River winter-run Chinook salmon. Southwest Region, Long Beach, CA, August 1997.
- Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in Sacramento- San Joaquin Delta with observations on food of sturgeon. In J.L. Turner and D. Kelley (eds), Ecological Studies of the Sacramento-San Joaquin Delta. California Department of Fish and Game, Fish Bulletin 136: 115-129.
- Stevens, D.E., L.W. Miller, and B.C. Bolster. 1990. A status review of the delta smelt, (*Hypomesus transpacificus*) in California. California Department of Fish and Game. Candidate Status Report 90-2.

- U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1998. "Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual: Inland Testing Manual". EPA-823-B-98-004.
- U.S. Fish and Wildlife Service. 1993. Federal Register, Vol. 58, No. 114. 50 CFR Part 226 – Designated Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California.
- U.S. Fish and Wildlife Service. 1994. Federal Register, Vol. 59, No. 242. 50 CFR Part 17 - Endangered and Threatened Wildlife and Plants: Critical Habitat Determination for the Delta Smelt, Final Rule.
- U.S. Fish and Wildlife Service. 1994a. Preliminary Draft Handbook for Habitat Conservation Planning and Incidental Take Permit Processing. U.S. Department of the Interior Fish and Wildlife Service. 94 pp. + Appendices.
- U.S. Fish and Wildlife Service. 1994b. Formal Endangered Species Consultation on Middle Shoals Sand Extraction in Permits 19128E10A (Olin Jones), 15050E559A (Jerico), and 19597E59 (Tidewater), Middle Grounds Shoal, Suisun Bay, Solano County, California. USFWS to COE. USFWS Ecological Services, Sacramento, California.
- U.S. Fish and Wildlife Service. 1995. Sacramento/San Joaquin Delta Native Fishes Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.

Appendix A

NATURAL HISTORY OF DELTA SMELT

The delta smelt is a small euryhaline fish which reaches adult sizes of about 55-70 mm standard length (Moyle 1976, 2002; Moyle et al. 1989), although some may reach lengths near 130 mm (Stevens et al. 1990). Delta smelt are translucent with a silvery, steel-blue streak along their sides. Related smelt species found in the Sacramento-San Joaquin Estuary include longfin smelt (*Spirinchus thaleichthys*) and wakasagi (*Hypomesus nipponensis*) (Moyle 1976; DFG unpublished data). Other marine smelt species historically observed in the Estuary include whitebait smelt (*Allosmerus elongatus*), surf smelt (*Hypomesus pretiosus*), and night smelt (*Spirinchus starksi*) (Wang 1986). The marine species generally do not occur where delta smelt have historically been common.

General Distribution

A number of factors may influence size and distribution of the delta smelt population. These may include Delta outflow and location of different salinity levels, entrainment into a variety of Delta diversions, reverse flow, predation and competition with native and introduced species, food abundance, water quality, contaminants, disease and parasites, and spawning stock size.

Delta smelt commonly occur, presumably in schools, in the surface and shoal waters of the lower reaches of the Sacramento River below Isleton, the San Joaquin River below Mossdale, through the Delta and into Suisun Bay (Moyle 1976; Moyle et al. 1992). Delta smelt are generally found only in the Sacramento-San Joaquin Estuary (Stevens et al. 1990; Moyle et al. 1992). However, during spawning delta smelt have been found as far upstream in the Sacramento River as the mouth of the Feather River (Wang 1991). In high flow years, delta smelt may also be washed temporarily into San Pablo Bay (Moyle et al. 1992; Fry 1973), as occurred in the winter of 1992-93, or possibly even farther downstream. They have been found in the Napa River as well (pers. comm., Michael Dege, DFG). When not spawning, delta smelt tend to concentrate just upstream of the entrapment zone in the vicinity of the 2 ppt salinity isohaline.

The entrapment zone is a transient region of the estuary where fresh water and salt water interact to elevate the level of suspended particulate matter. It is formed as fresh water flows downstream over the denser, landward-flowing, salt water; creating a circulation pattern that concentrates particles such as sediment and plankton. An operational definition of 2 ppt isohaline position (X2) is frequently used as an index of the upper boundary of entrapment zone position, even though it is not strictly equivalent to that boundary (Arthur and Ball 1978; Kimmerer 1992). Location of the entrapment zone is regulated by the interaction of tides, Delta outflow, and the complex bathymetry of the estuary, as well as mixing by wind in shallow waters (Peterson et al. 1975; Arthur and Ball 1978). The entrapment zone often occurs between Honker Bay and Sherman Island, but in response to extreme conditions it ranges from below Suisun Bay (wet years) to above Rio Vista (critical

years).

The western Suisun Bay is reportedly the normal down stream limit of the Delta smelt. When the entrapment zone is in Suisun Bay and both deep and shallow water exists, delta smelt are caught most frequently in shallow water (Moyle et al. 1992). Delta smelt are usually found in euryhaline, or brackish waters where salt and freshwater mix, but they move to freshwater to spawn (Moyle 1976). Large numbers of delta smelt are entrained in the state and federal water facilities and therefore undoubtedly some are present in the Delta-Mendota Canal and California aqueduct. No delta smelt have been observed in either San Luis Reservoir or O'Neil Forebay, and since any individuals that might be in either facility have no mechanism to contribute to future generations in the Estuary their status will not be discussed further.

Age and Growth

Delta smelt are fast growing and short-lived (Moyle 1976). The majority of growth occurs within the first 7 to 9 months of life when the fish reaches approximately 50-70 mm in length (Erkkila et al. 1950). After this period growth slows to allow for reproductive development (Radtke 1966; Moyle 1976). Most delta smelt die after spawning at age 1 in spring, however a few survive a second year and can grow to lengths near 130 mm (Stevens et al. 1990).

Diet

Delta smelt feed entirely on zooplankton (Stevens et al. 1990; Moyle et al. 1992). Gut samples taken during larval stages indicate that delta smelt diet consists of primarily of adult and juvenile, calanoid copepods, especially Eurytemora and Pseudodiaptomus. (Stevens et al. 1990, Lott 1998). As the smelt grows, their primary prey become larger adult copepods (DFG 1993), and their diet becomes more varied in the late winter and early spring months (Lott 1998).

Reproduction

Shortly before spawning, adult delta smelt migrate upstream from the brackish-water habitat associated with the entrapment zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966; Moyle 1976; Wang 1991). The time of spawning varies from year to year and may start in early December and extend until July (USFWS 1994). Moyle (1976) reported ripe females from December to April with the majority of the smelt collected during February through March. Wang used 1989 and 1990 data and found that spawning occurred from mid-February to late June or July with peaks in late April and early May. Wang suggested that because of the long spawning season, delta smelt might be (fractional spawners) or alternatively, that different individuals mature at different times to ensure better chances of survival. Recent histological analysis did not support the fractional spawning theory because all of the eggs develop synchronously (Serge Doroshov in DFG 1993).

A-2

Spawning has been reported to occur at about 45-59 F (7.2 – 15.0 C) in rivers and sloughs, including dead-end sloughs and shallow edge-waters of the upper Delta and Sacramento River above Rio Vista (Radtke 1966; Wang 1986). Evidence of some spawning has also been recorded in Montezuma Slough and in Suisun Slough (P. Moyle unpublished in USFWS 1995). Recently, juveniles were discovered during sampling in the Napa River, indicating that spawning was occurring in that location. The fate of juveniles in the Napa River is unknown (Mike Dege, DFG, pers. comm. 2002). Study results from UC Davis (Swanson and Cech 1995) have indicated that although delta smelt can tolerate a wide range of water temperature (< 8 C to > 25 C), warmer temperatures restrict their distribution more than colder temperatures.

Most spawning occurs in fresh water, but some may occur in brackish water in or near the entrapment zone (Wang 1991). Spawning occurs in the water column above, or adjacent to, a variety of substrates including emergent and aquatic vegetation and rocky substrates. As smelt eggs descend through the water column the outside adhesive layer of the chorion folds back and attaches to the available substrate (Wang 1986). Delta smelt eggs likely attach to rocks, gravel, tules, cattails, tree roots, and emergent vegetation (Wang 1986; Moyle et al. 1992). Preferred substrates for delta smelt egg attachment are unknown; and, due to the adhesive nature of the eggs, any substrate in the water column is a potential site for egg attachment. The Interagency Ecological Program will be investigating substrate and depth preference for delta smelt egg attachment during the next couple of years.

Laboratory observations indicate that delta smelt are broadcast spawners that spawn in a current, usually at night, distributing their eggs over a local area (Lindberg 1992; Mager 1993). In 1992, delta smelt eggs were hatched in 9-14 days under laboratory conditions, at temperatures ranging from 13-16 C (Mager pers. comm. in DFG 1993). Exogenous feeding began at 5-6 days posthatch, at temperatures ranging from 14-16 C with two-thirds of the yolk absorbed (Mager pers. comm. in DFG 1993).

Newly hatched larvae have a large oil globule that makes them semi-buoyant. This allows them to maintain themselves just off the bottom, where they feed on rotifers and other microscopic prey. Once the swimbladder develops, larvae become more buoyant and rise up higher in the water column where they begin to feed on zooplankton. The larvae drift with the downstream currents toward the entrapment zone (Wang 1986; Stevens et al. 1990; Moyle et al. 1992).

The location of the entrapment zone in the Estuary depends on flow conditions which may be influenced by outflow, water export rates, and Delta Cross-channel operations. Delta smelt larvae are retained at the entrapment zone by the vertical circulation of fresh and salt waters (Stevens et al. 1990). The pelagic larvae and juveniles feed on zooplankton. When the entrapment zone is located in a broad geographic area with extensive shallow-water habitat in depths of less than 4 meters, high densities of phytoplankton and zooplankton are produced. Under these conditions, larval and juvenile fish, including delta smelt, grow rapidly (Moyle et al. 1992; Sweetnam and Stevens 1993). If the entrapment zone is

within the Suisun Bay, young delta smelt are scattered widely throughout the large expanse of shallow water and marsh habitat (USFWS 1994).

Reasons for Decline

Reduction in outflows is attributed to increases in upstream storage and diversion of water from the Sacramento and San Joaquin rivers and their tributaries, particularly in combination with dry years. This reduces fresh water available to flush through the estuary. Diversions may also create reverse flows in the lower San Joaquin River, making delta smelt more vulnerable to entrainment. For fishes and most other Delta organisms, moderately high spring outflows are important because they cause the mixing zone or entrainment zone of the estuary to be located in Suisun Bay. The mixing effect allows phytoplankton, zooplankton, and larval fish to remain in the mixing zone rather than being flushed out to sea.

Entrainment losses to water diversions are closely tied with the reduction in outflows because as diversions increase in drier years, there is less fresh water available to transport larval and juvenile fish to Suisun Bay. Water is pumped out of the system through numerous small diversions for Delta farms and large diversions of the Central Valley Project (CVP) and State Water Project (SWP). Water is also pumped through power plant cooling systems. Recent analyses by the Department (1987; 1992 WRINT-Exhibits 2 and 3) indicate that entrainment of young fish in these diversions has been a major cause of the ongoing decline of striped bass. It is likely that this entrainment loss is also a major factor affecting delta smelt populations, as delta smelt are ecologically similar to larval and juvenile striped bass.

Years of major delta smelt decline have been characterized not only by unusually dry years with exceptionally low outflows (1987-1991), but also by unusually wet years with exceptionally high outflows (1982, 1983, and 1986). High outflows presumably flush delta smelt out of the system along with much of the zooplankton. This means that not only is potential spawning stock reduced, but the food supply as well. The depletion of established populations of invertebrates and fish may also make it easier for exotic species to become established to the detriment of delta smelt.

Since the early 1970's, a number of exotic species, including both fish and invertebrates, have been accidentally introduced into the Sacramento-San Joaquin Estuary and become firmly established. The efficiency of delta smelt feeding may also have been affected by several copepods which have become abundant within the past 15 years, one of which, *Sinocalanus doerrii*, has been shown to be less vulnerable prey than the native *Eurytemora*. Increased competition for food may also be occurring due to an unexplained population explosion of the Shimofuri goby (*Tridentiger bifasciatus*) that occurred in 1990 (DFG 1993). Another similar introduced species is the Shokihaze goby (*T. barbatus*), first captured in California in the San Joaquin river in 1997 (Greiner 2002). While the decline in delta smelt did not coincide with the increase in exotic species, competition could have played

some role in the decline. In addition, while many introduced species have only recently become abundant, subsequent increases in exotic species may inhibit recovery of the delta smelt.

A closely related smelt, the wakasagi was introduced into several California reservoirs in the late 1950s and 1960s. CDFG surveys in 1995 and 1996 found wakasagi in the Sacramento- San Joaquin estuary (Aasen et al. 1998). In Moyle and Davis (2000), wakasagi are listed as an “I5 species”, meaning that they are considered to be widespread and expanding. There has been concern that hybridization between delta smelt and wakasagi might be possible if they should coexist, and therefore that there is potential for dilution of the delta smelt gene pool. Taken far enough, this dilution could lead to the elimination of its existence as a separate species. However, although F1 hybrids have been found in the estuary (Moyle 1995), no F2 individuals have been observed. Because of the large genetic divergence between delta smelt and wakasagi, Stanley et al. (1995) suggested that the F1 hybrids are infertile and there was no genetic threat at that time. Stanley et al. did suggest, however, that if wakasagi should become more abundant; hybridization with delta smelt, even if it results in sterile offspring, may become a concern because of the lost reproductive effort it would represent. Moreover, while hybridization may not be a threat at this time, increased competition from wakasagi is possible because both fish have similar feeding habits and diets (DFG 1993, Aasen, et al 1998).

The waters of the estuary receive a variety of toxic substances, including agricultural pesticides, heavy metals, and other products from urban storm water runoff. The effects of these compounds on larval fishes and their food supply are poorly known, but there is growing evidence of additional stress to and even direct mortality of larval striped bass from low concentrations of toxic substances (USFWS 1995; Bennett et al. 1995). There is also evidence that planktonic organisms upon which delta smelt feed may be periodically depleted by brief flushing of high concentrations of pesticides (e.g. carbofuran) through the system (USFWS 1995). It is not known if these substances also are affecting delta smelt.

Most of the species that now inhabit the Delta are non-native, including fishes that feed on zooplankton during some life stages. There is currently no evidence that disease, competition, or predation has caused delta smelt populations to decline, despite the abundance of introduced species in the estuary (USFWS 1995). However, if predation is a factor in the decline of delta smelt , an introduced species may be responsible. Introduced species colonize rapidly under favorable conditions and may disrupt the structure of fish communities by competing with or preying on native fishes (Herbold and Moyle 1986).

The species likely to have the greatest effect are the inland silverside (*Menidia beryllina*) (introduced in 1975) and the yellowfin (*Acanthogobius flavimanus*) and Shimofuri gobies (both introduced in the late 1950s). Shimofuri gobies are not a likely suspect, since they have been abundant in the upper estuary and Delta only since the mid-to-late 1980s. However, they may limit the recovery of delta smelt populations. Inland silverside, which could prey on delta smelt eggs and larvae, has been collected where delta smelt are spawning (Moyle et al. 1993); but its measured abundance has been

highly variable (Sweetnam and Stevens 1993). Recent predation experiments using large field enclosures in the estuary (Bennett et al. 1993) indicate that inland silversides readily consume striped bass larvae (5-8 mm SL), producing higher daily mortality rates than those reported in similar experiments using larval fish prey and other small fish predators (Fuiman and Bamble 1988; Pepin et al. 1992; and Cowan and Houde 1993, cited in Bennett and Moyle 1993). Prey selection was also found to be size-based. Therefore, since smelt larvae are similar in size to the striped bass larvae used by Bennett et al (1993), they would likely be consumed if encountered by inland silversides.

Finally, low outflow may exacerbate any predation on delta smelt by concentrating the spawning smelt in areas of high silverside abundance in the Delta. Because productivity in the Sacramento-San Joaquin estuary is relatively low compared to other estuaries, food limitation in the estuary may contribute to competition among species. Evidence of this phenomenon has not been documented, however introduced fish and invertebrate species may compete directly with delta smelt (adults and young) for food (phytoplankton and zooplankton) or may alter the species composition of the zooplankton community. Young striped bass, American shad (*Alosa sapidissima*), threadfin shad (*Dorosoma petenense*), inland silverside, Shimofuri goby, and wakasagi are all zooplankton feeders and could compete with delta smelt for food.

In the Bay/Delta system, low food abundance and changing composition suggest food may be limiting for both larval and adult smelt (Moyle et al. 1992). Bennett and Moyle (1993) investigated potential competition of inland silverside with delta smelt. Silversides form dense schools in shoal areas, whereas smelt are more abundant in river channels; this does suggest some degree of habitat segregation. However, they theorize that considerable overlap may occur between the species at prime feeding times. Such behavior could produce locally depressed food resources for delta smelt at favored feeding sites and times, increasing the probability of resource competition.

LITERATURE CITED

- Aasen, G. A., D.A. Sweetnam, and L. M. Lynch. 1998. Establishment of the Wakasagi, *Hypomesus nipponensis*, in the Sacramento-San Joaquin estuary. California Fish and Game 84(1):31-35.
- Arthur, J.F., and M.D. Ball. 1978. Entrapment of suspended materials in the San Francisco Bay-Delta Estuary. U.S. Department of the Interior, Bureau of Reclamation. 106 pp.
- Bennett, W.A., L. Rogers-Bennett, and P.B. Moyle. 1993. Interactive Influence of starvation and predation on mortality of striped bass larvae: a field experimental approach. Final report submitted for the Research Enhancement Program for the San Francisco Bay-Delta. 27 pp.
- Bennett, W.A., D.J. Ostrach, and D.E. Hinton. 1995. Larval striped bass condition in a drought-stricken estuary: evaluating pelagic food-web limitation. Ecological Applications, 5(3):680-692.
- California Department of Fish and Game. 1987. Delta outflow effects on the abundance and distribution of San Francisco Bay fish and invertebrates, 1980 - 1985. Exhibit 60 for the State Water Resources Control Board 1987 Water Quality/Water Rights Proceeding on the San Francisco Bay/Sacramento-San Joaquin Delta.
- _____. 1992. Written testimony. Submitted as Wrint- DFG Exhibit 2 and 3 to the State Water Resources Control Board.
- Doroshov, Serge, University of California at Davis. Pers. Comm. Primary Investigator who had a contract (1992, 1993) with the Department of Water Resources to culture delta smelt in the laboratory and to study gametogenesis and reproductive development of delta smelt.
- Erkkila, L.F., J.W. Moffet, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin Delta fishery resources: Effects of Tracy Pumping Plant and the Delta Cross channel. U.S. Fish and Wildlife Service Special Scientific Report 56:1-109.
- Fry, D.H. 1973. Anadromous fishes of California. California Department of Fish and Game. 112pp.
- Greiner, T. A. 2002. Records of the Shokihaze Goby, *Tridentiger barbatus* (Günther), Newly Introduced into the San Francisco Estuary. California Fish and Game 88(2):68-74.
- Herbold, B. and P.B. Moyle. 1986. Introduced species and vacant niches. American Naturalist 128: 751-760.

- Kimmerer, W.J. 1992. An Evaluation of Existing Data in the Entrapment Zone of the San Francisco Bay Estuary. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Technical Report 33.
- Lindberg, J.C. 1992. Development of delta smelt culture techniques. Prepared for Department of Water Resources. Biosystems Analysis, Inc. 22 pp.
- Lott, J. 1998. Feeding habits of juvenile and adult delta smelt from the Sacramento - San Joaquin river estuary. Interagency Ecological Program Newsletter 11(1):14-19.
- Mager, R. 1993. Delta smelt culturing. Pages 2-3 in W. Kimmerer. Minutes of the March 1993 Food Chain Group Meeting. Department of Water Resources. April 22, 1993, memo. 8 pp.
- Mager, Randy, University of California at Davis. Pers. Comm. Researcher under P.I. Serge Doroshov who has a contract (1992, 1993) with the Department of Water Resources to culture delta smelt in the laboratory and to study gametogenesis and reproductive development of delta smelt.
- Mills, T.J. and F. Fisher. 1994 (in draft). Central Valley Anadromous Sport Fish Annual Run-size, Harvest, and Population Estimates, 1967 through 1991. Inland Fisheries Technical Report, California Department of Fish and Game.
- Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley. 405 pp.
- Moyle, P.B. 2002. Inland Fishes of California. University of California Press, Berkeley. 576 pp.
- Moyle, P.B., and B. Herbold. 1989. Status of the Delta smelt Hypomesus transpacificus. Final Report to U.S. Fish and Wildlife Service. Department of Wildlife and Fisheries Biology, University of California, Davis: 1-19 + Appendix.
- Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society. 121: 67-77.
- Peterson, D.H., T.J. Conomos, W.W. Broenkow, and P.C. Koherty. 1975. Location of the Non-tidal Current Zone in Northern San Francisco Bay. Estuarine and Coastal Marine Science. 3:1-11.

- Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in Sacramento- San Joaquin Delta with observations on food of sturgeon. In J.L. Turner and D. Kelley (eds), Ecological Studies of the Sacramento-San Joaquin Delta. California Department of Fish and Game, Fish Bulletin 136: 115-129.
- Stanley, S.E.; P.B. Moyle; and H.G. Shaffer. 1995. Allozyme analysis of delta smelt, *Hypomesus transpacificus* and longfin smelt, *Spirinchus thaleichthys* in the Sacramento-San Joaquin Estuary, California. Copeia 1995:390-396.
- Stevens, D.E., L.W. Miller, and B.C. Bolster. 1990. A status review of the delta smelt, (Hypomesus transpacificus) in California. California Department of Fish and Game. Candidate Status Report 90-2.
- Swanson, C. and J.J. Cech, Jr. 1995. Environmental Tolerances and Requirements of the Delta Smelt, *Hypomesus transpacificus* (Final Report). University of California, Davis, Department of Wildlife, Fish, and Conservation Biology.
- U.S. Fish and Wildlife Service. 1994. Federal Register, Vol. 59, No. 242. 50 CFR Part 17 - Endangered and Threatened Wildlife and Plants: Critical Habitat Determination for the Delta Smelt, Final Rule.
- _____. 2004. Biological Opinion on Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues. Service file # 1-1-05-F-0055.
- Sweetnam, D.A., and D.E. Stevens. 1993. Report to the Fish and Game commission: A Status Review of Delta Smelt (Hypomesus transpacificus) in California. California Department of Fish and Game. Candidate Species Status Report 93-DS.
- Wang, J.H. 1986. Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Technical Report 9. Sacramento, California.
- Wang, J.H. 1991. Early life stages and early life history of the delta smelt, Hypomesus transpacificus, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, Spirinchus thaleichthys. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Technical Report 28. 52pp.

APPENDIX B

Map of Delta Smelt Critical Habitat (USFWS)

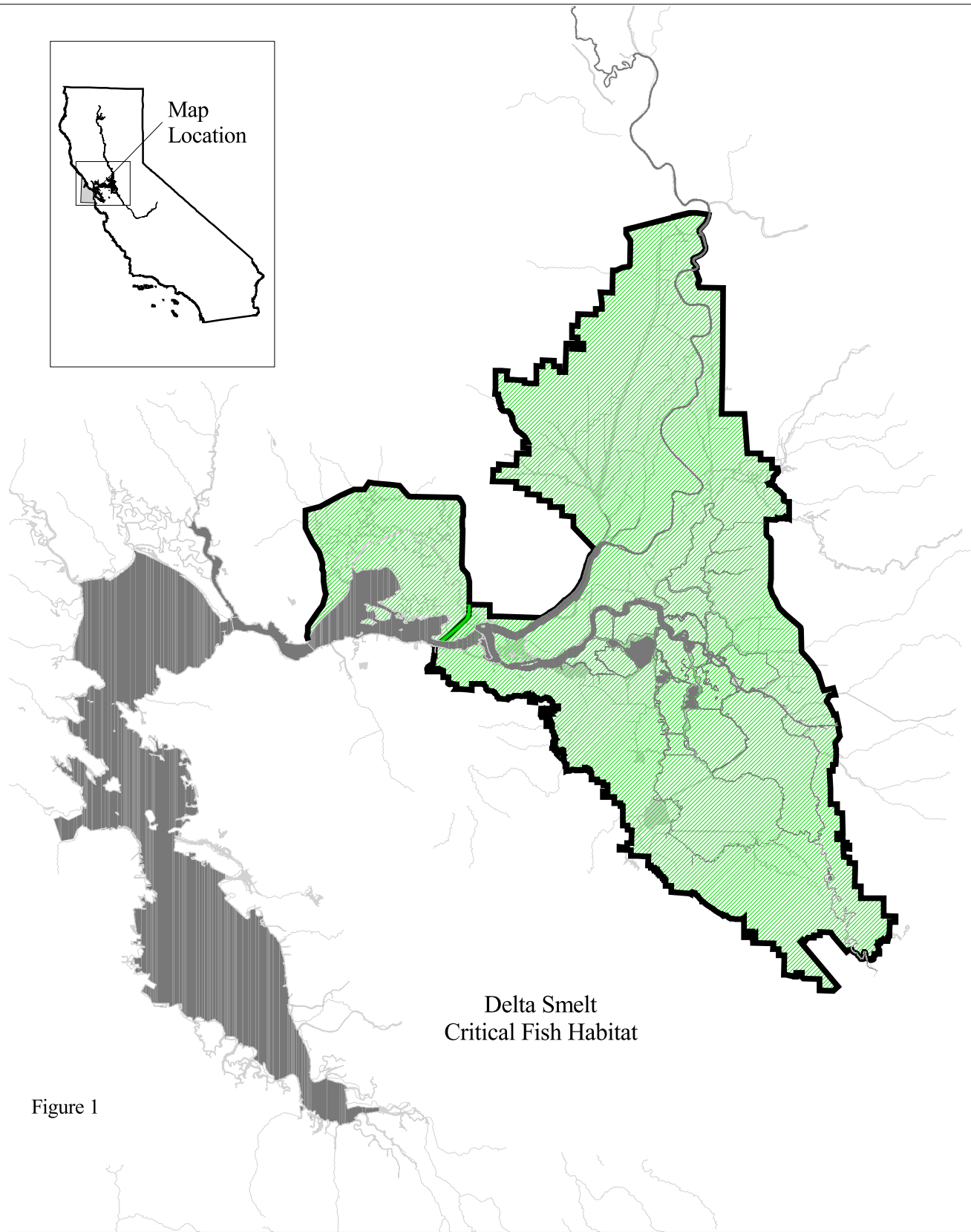
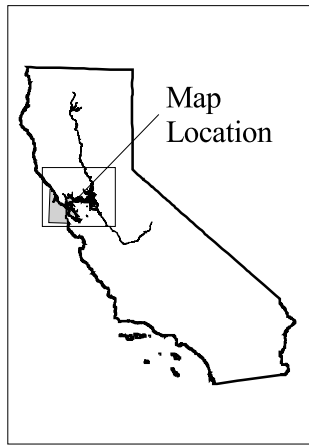


Figure 1

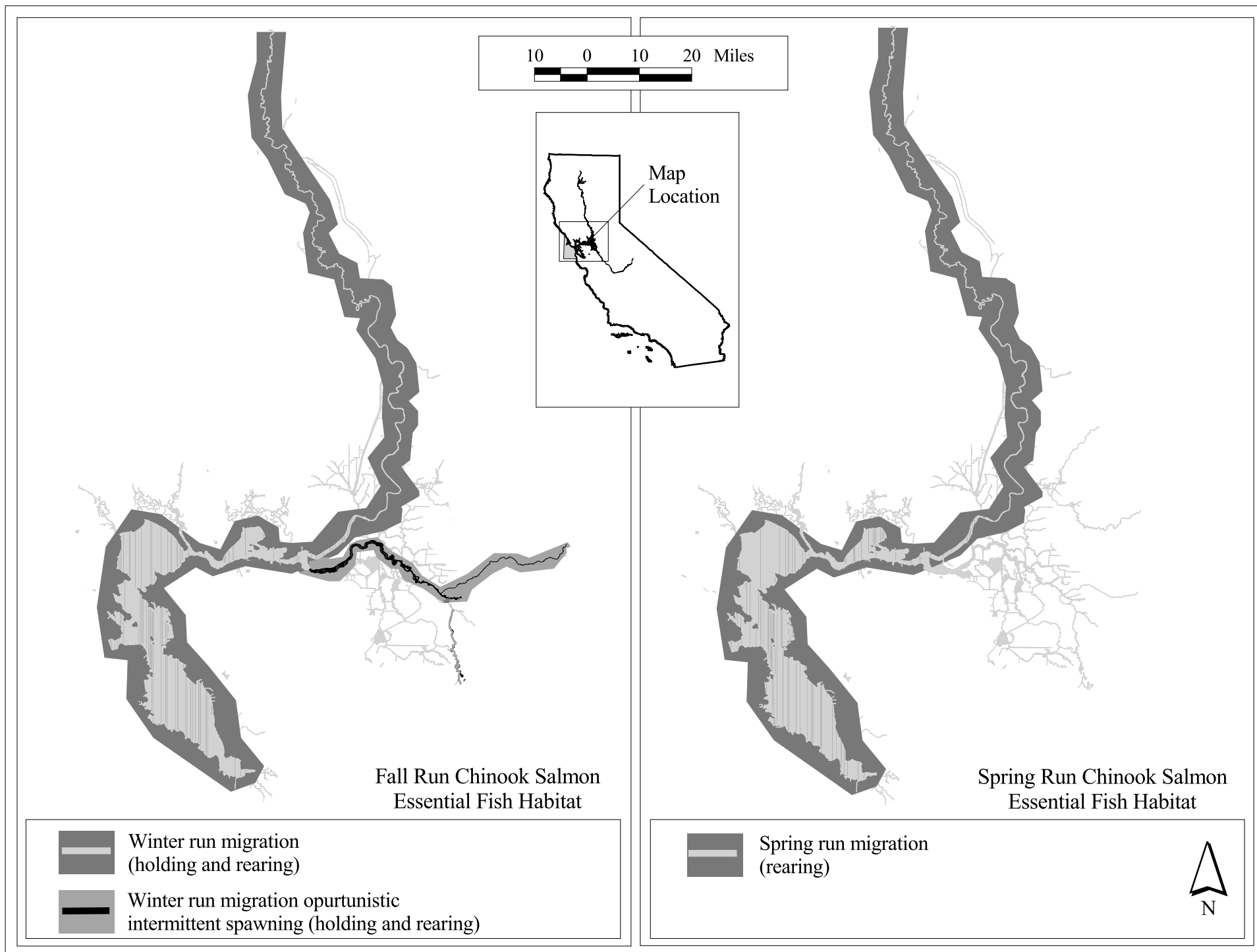


Delta Smelt Critical Habitat
(migration and rearing)



APPENDIX C

Maps of Winter- and Spring-run Chinook Salmon Essential Fish Habitat (USFWS)



Appendix D

Description of Protection Zones for Delta Smelt and Winter- and Spring-run Chinook Salmon

(The following are descriptions of the zones depicted in Figure 2)

Zone A:

Mainstem of the Napa River and all rivers east of the confluence of the Napa River and Carquinez Strait to the confluence of the Sacramento and San Joaquin rivers, then south and east to the confluence of the Contra Costa Canal and Marsh Creek. This zone includes everything north of and including Rock Slough, Old River from the confluence with Rock Slough to the confluence with Middle River, Middle River to confluence with Empire Cut, Turner Cut, and the San Joaquin River to the Stockton Deep Water Ship Channel. The northern boundary of this zone is a line across the Sacramento River, at the downstream side of the Highway 50 Bridge. East of Highway 5, the boundary of this zone is Pacific Avenue and Thornton Road north to the town of Thornton, then east to the confluence of Mokelumne River and Dry Creek, upstream to the confluence of Dry Creek and Grizzly Slough, north through Grizzly Slough to the confluence of Grizzly Slough and Bear Slough and the confluence of Grizzly Slough and Cosumnes River and all areas downstream of the confluence of Cosumnes and Grizzly Slough.

Zone B:

All rivers, channels, and sloughs south of the confluence of Old River and Rock Slough; Middle River and Empire Cut, including Burns Cutoff; the San Joaquin River south of the confluence with the Stockton Deep Water Ship Channel to the confluence with French Camp Slough, Middle River from its confluence with Empire Cut south to the confluence with Old River; and Old River from the downstream side of its confluence with Paradise Cut, west to the Central Valley Project Fish Salvage Facility and to the entrance of Clifton Court Forebay.

Zone C:

Southern- All rivers, channels, and sloughs located south and east of the confluence of the San Joaquin River and French Camp Slough, the downstream side of the confluence of Old and Middle rivers; and the downstream side of the confluence of Old River and Paradise Cut and Tom Paine Slough.

Northern - The northern section of Zone C includes all rivers, channels, and sloughs located

north of a line which extends through the Sacramento River on the downstream side of the Highway 50 Bridge, up to the downstream side of the confluence of Feather River and Sacramento River.

Western- The western section of Zone C is all waterways west of the mainstem of the Napa River and its confluence with the Carquinez Strait.